

Solutions

Unit objectives *You will be able to...*

- **Identify parts of a solution**
- **Calculate absolute and relative quantities of solution (mixtures; heterogeneous and homogeneous) components.**
- **Apply concepts of concentration units to stoichiometry**
- **Calculate Mole quantities in absolute terms for concentration and dilutions**
- **Calculate dilutions**
- **Make solutions to specific concentrations using volumetric glassware from both solid and liquid solutes**

Solubility

Not all ionic compounds dissolve!

Instead of doing experiments all the time to see which ones will dissolve, we use The solubility rules.

Solubility Rules

1. All nitrates (NO_3^-) are soluble.
2. All ammonium (NH_4^+) or alkali (Li^+ , Na^+ , K^+ , Rb^+ , Cs^+ , Fr^+) compounds are soluble.
3. All carbonates (CO_3^{2-}), phosphates (PO_4^{3-}) and hydroxides (OH^-) are insoluble except with the cations in Rule #2.
4. All chlorides (Cl^-), bromides (Br^-), and iodides (I^-), are soluble except with Ag^+ , Pb^{2+} , or Hg^+ .
5. All sulphates (SO_4^{2-}) are soluble except with Ca^{2+} , Sr^{2+} , Ba^{2+} , Ra^{2+} , Pb^{2+} ,

Net Ionic Equation Review, cont. 3


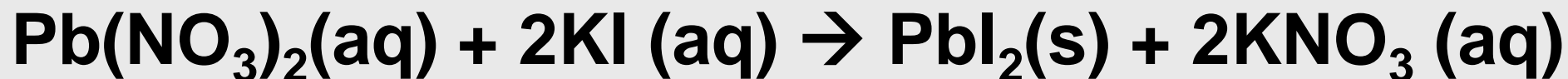
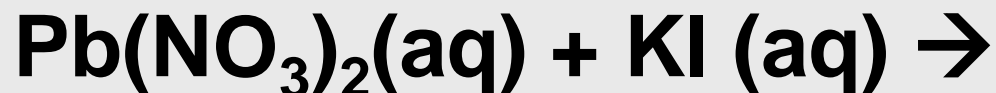
Practice

Which of the following are soluble in water?

- 1. SrSO_4**
- 2. NaNO_3**
- 3. PbCl_2**

Net Ionic Equation Review, cont. 4

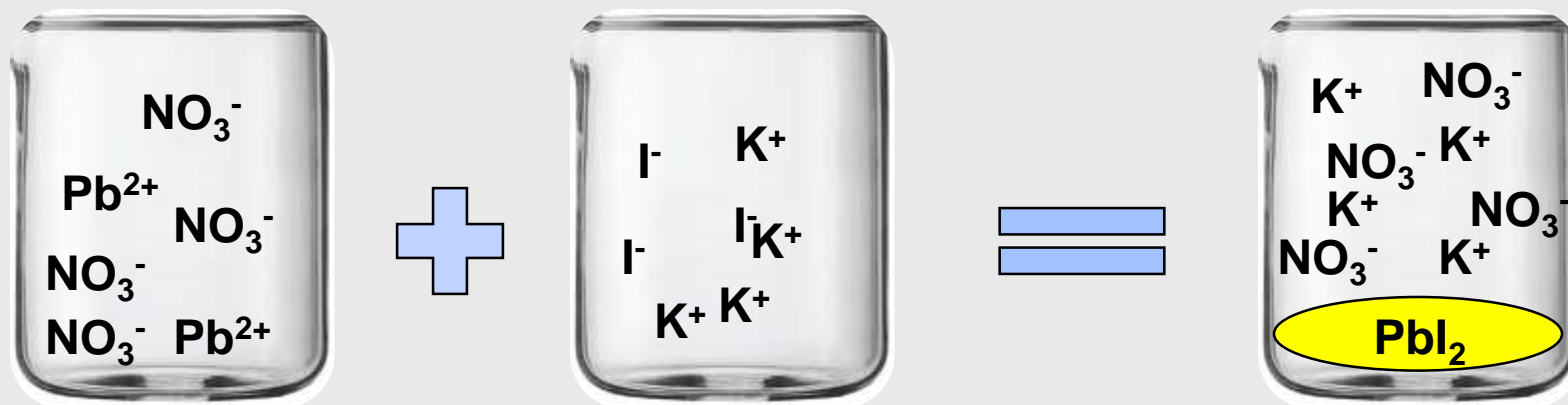
Predict the products of the following reaction: (if no solid precipitate is formed, there is no rxn)



We know it is a solid precipitate because it is insoluble according to the solubility rules.

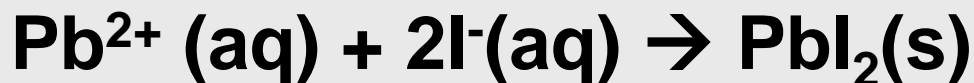
Net Ionic Equation Review, cont. 5

View of the Rxn Ions



Because K^+ and NO_3^- remain dissolved, they are called spectator ions and are not included in the net ionic equation.

Net Ionic Equation



Net Ionic Equation Review, cont. 6

Solubility Practice

Which are soluble



Net Ionic Equation Review, cont. 7

Precipitation Reactions

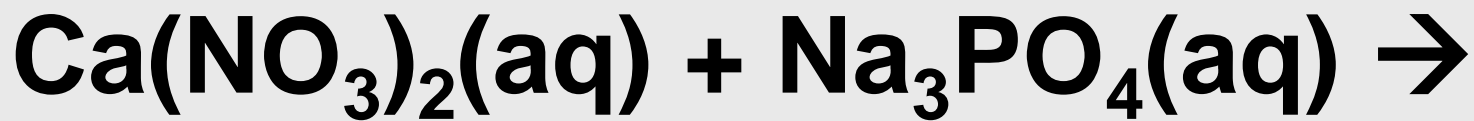
When a solid doesn't dissolve it is called insoluble.

A solid that forms when two solutions are mixed is called a precipitate.

Denoted as (s) in a chemical equations

Net Ionic Equation Review, cont. 8

**Based on the reactants below,
what is the precipitate and
balance?**



BELL WORK

9-April-18

What is a solution?

Try explaining it as if you were writing to a friend not to Mr. Golden

What is an ionic compound?

Agenda:

Parts of a Solution

Polarity

Molarity

Objective: You will UNDERSTAND how to calculate molarity, and APPLY your knowledge to making solutions

Turn In, 9 April 18

- **Remainder of
Stoichiometry**

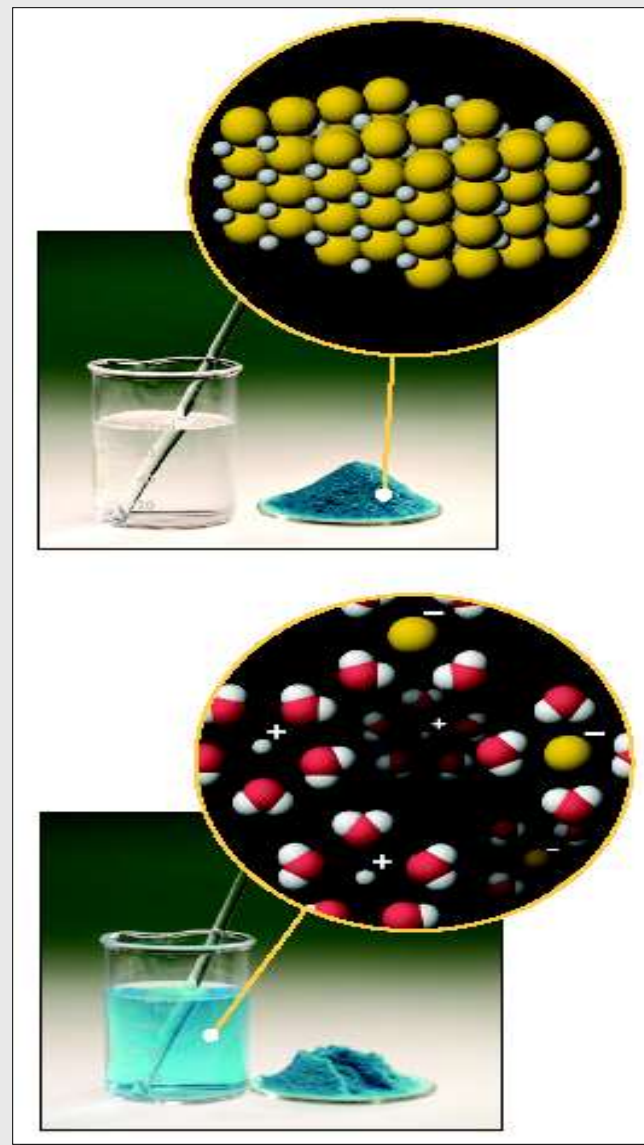
Some Definitions

A solution is
formed when a
Solvent

and

Solute

are mixed.



PARTS OF SOLUTIONS

SOLUTE –part of a solution
that is being dissolved
(usually the lesser amount)

SOLVENT –part of a solution
that dissolves the solute
(usually the greater amount)

Solute + Solvent = Solution

Definitions



Solutions can be **saturated** or **unsaturated**.

Saturated solution contain the maximum amount of solute.

An **unsaturated** solution contains less solute than a solvent can hold at a particular temp.

Definitions

SUPERSATURATED SOLUTIONS

contain more solute than a solvent can hold

They are unstable. The super saturation is only temporary, and usually accomplished in one of two ways:

To Make a Supersaturated Solution

- 1. Warm the solvent so that it will dissolve more, then cool the solution**
- 2. Evaporate some of the solvent carefully so that the solute does not solidify and come out of solution.**

Supersaturated Rock Candy

This supersaturated sucrose and food coloring solution uses a “seed” crystal to make...



**Crystal Rock
candy**

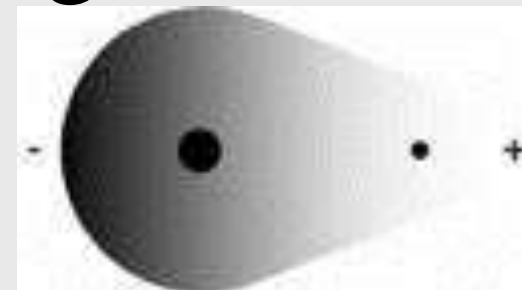
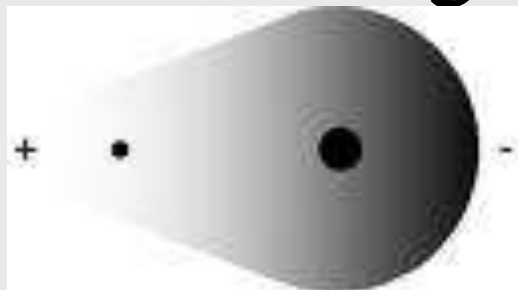
Factors affecting solubility

1. Heat increases solubility in most liquids

*** solubility of gases are greater in cold water than hot.**

2. True: the solubility of gas increases w/ increasing pressure

Factors affecting solubility



3. Polar molecules will only dissolve in Polar molecules

Non- polar molecules will only dissolve in non-polar molecules

“ like dissolves like ”

RATE OF DISSOLUTION

Several Factor determine the rate a substance dissolves

1. Agitation helps a solute to dissolve because it brings fresh solvent into contact w/ the solute
2. A greater Surface area of solute is exposed to the colliding water molecules

RATE OF DISSOLUTION

Several Factor determine the rate a substance dissolves

3. **Energy** also influences the rate at which a substance dissolves. The **higher** energy leads to increased frequency and **number** of the collision of water molecules w/ crystal surfaces

Question

A solution is made up of 25 grams of cyclohexane (non-polar) and 7 grams of acetonitrile (polar).

What is the solute ?

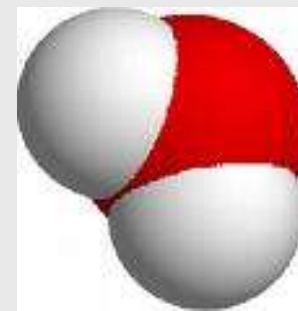
What is the solvent?

Would you expect the solvent to readily mix with the solute?



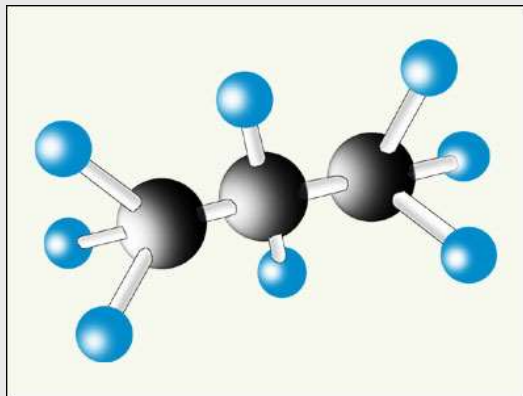
Polarity

"polar" molecules: An uneven distribution of electron density. Ex. water H₂O



“non polar” molecules: an even distribution of electron density.

Ex. Oil, propane, etc.



<http://www.youtube.com/watch?v=PVL24HAesnc>

[http://www.youtube.com/watch?v=LKAjTE7B2x0
&feature=related](http://www.youtube.com/watch?v=LKAjTE7B2x0&feature=related)

Solution Quick Review

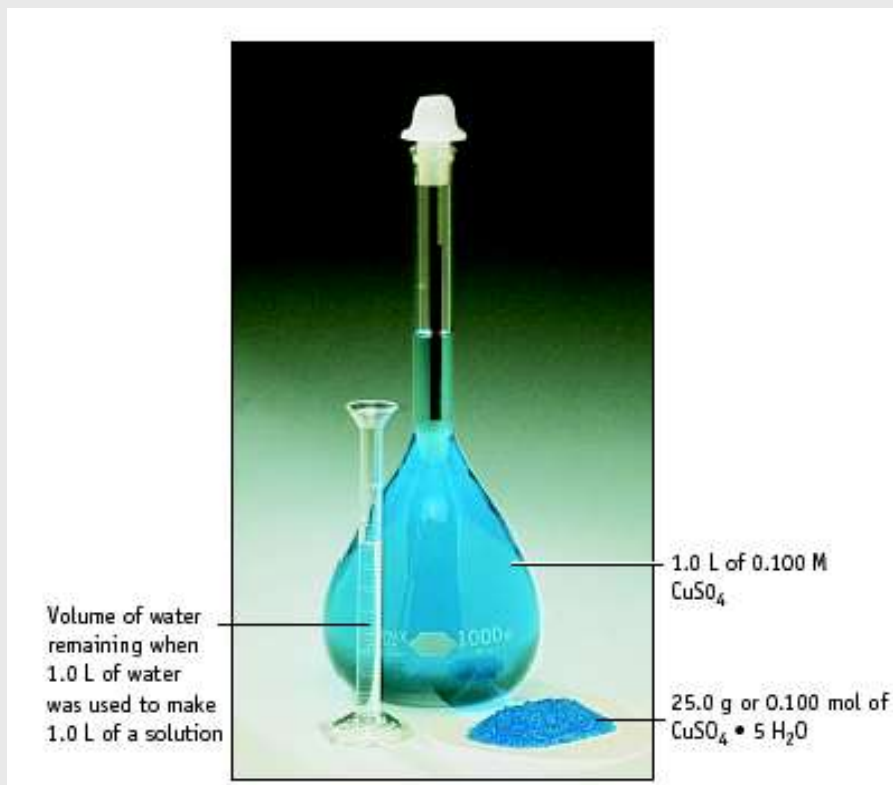
<http://www.youtube.com/watch?v=9h2f1Bjr0p4>

Concentration of a solution

The amount of solute in a solution is given by its concentration.

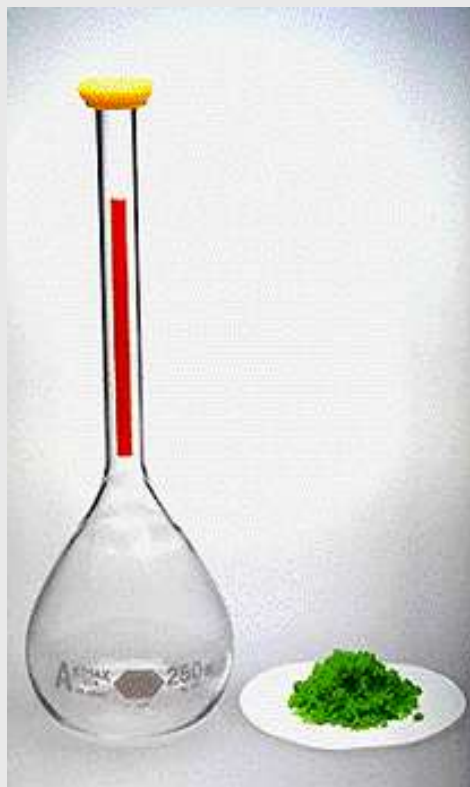
$$\text{Molarity (M)} = \frac{\text{moles solute}}{\text{liters of solution}}$$

**1.0 L of
water was
used to
make 1.0 L
of
solution.
Notice the
water left
over.**



Practice

**Dissolve 5.00 g of NiCl_2 in enough water to make 250 mL of solution.
Calculate the Molarity.**



Dissolve 5.00 g of NiCl_2 in enough water to make 250 mL of solution. Calculate the Molarity.

Step 1: Calc. moles of NiCl_2

$$5.00 \text{ g} \cdot \frac{1 \text{ mol}}{129 \text{ g}} = 0.0388 \text{ mol}$$

Step 2: Calculate Molarity

$$\frac{0.0388 \text{ mol}}{0.250 \text{ L}} = 0.155 \text{ M}$$

$$[\text{NiCl}_2] = 0.155 \text{ M}$$

Practice

What is the molarity of a 0.4L solution made with 0.5g CoCl_2 at 25°C.

How do you think temperature would affect the molarity?

Using Molarity

What mass of oxalic acid, $\text{H}_2\text{C}_2\text{O}_4$, is required to make 250. mL of a 0.0500 M solution?

$$\text{moles} = \frac{\text{mol}}{\text{L}} \times \text{L}$$

Using Molarity

What mass of oxalic acid, $\text{H}_2\text{C}_2\text{O}_4$, is required to make 250. mL of a 0.05 M solution?

Step 1: mL \rightarrow L.

$$\text{moles} = \frac{\text{mol}}{\text{L}} \times \text{L}$$

$$250 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} = 0.250 \text{ L}$$

Step 2: Calculate.

$$\text{Mol} = \frac{(0.05 \text{ mol})}{1 \text{ L}} (0.250 \text{ L}) = 0.0125 \text{ mol}$$

Step 3: Convert moles \rightarrow grams.

$$(0.0125 \text{ mol})(90.00 \text{ g/mol}) = 1.13 \text{ g}$$

Two Other Concentration Units

33

~~MOLALITY, m~~

$$\text{ ~~m of solution = } \frac{\text{mol solute}}{\text{kilograms solvent}}~~$$

% by mass

$$\% \text{ by mass} = \frac{\text{grams solute}}{\text{grams solution}} \times 100$$

Learning Check

A solution contains 15g Na_2CO_3 and 235g of H_2O . What is the mass %(m/m) of the solution?

- 1) 15% Na_2CO_3**
- 2) 6.4% Na_2CO_3**
- 3) 6.0% Na_2CO_3**

Determining Morality *Mini Lab*

Follow instructions exactly as written.

**If asked to add 30ml of water add 30ml
of water**

No Pre-Lab!

Determining Molarity Mini Lab

Calculate the molarities of the following solutions:

- 1) 2.3 moles of sodium chloride in 0.45 L of solution**
- 2) 0.09 moles of sodium sulfate in 12mL of solution.**
- 3) 120 g of calcium nitrite in 240mL of solution**
- 4) 98 g of sodium hydroxide in 2.2 L of solution**

Bell Work

13-April-2018

What is the molar mass of NiCl_2 ?

The molar mass of the hydrate $\text{NiCl}_2 \cdot 6\text{H}_2\text{O}$?

What are the steps to make a solution from a solid and water at a given concentration using a volumetric flask?



With so many variations for representing concentrations of liquid solutions, why is it important for you to understand what each is representing

Lab Time

“Molarity Practice Lab”

First and foremost do not break the volumetric flasks!

Each person must “make” at least one of the 2 solutions

Do all the calculation before we go into lab for your chemical set

And we will not be doing a full pre lab!!!!

Lab Time

“Molarity Practice Lab”

$$\% \text{ by m/v} = \frac{\text{g solute}}{100\text{mL solution}} \times 100$$

So... if we wanted a 100ml of 5.0% solution of $\text{NiCl}_2 \cdot 6\text{H}_2\text{O}$
we would:

Weight out: $0.05 = x / 100\text{mL}$

$$x = 5.0\text{g}$$

**Add 5.0g to 100ml volumetric flask
and fill *to* 100ml with DI water**

Lab Time
“Molarity Practice Lab”

Use the hydrate form of Copper
(II) Sulfate, $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$

Disposal:
Down sink

Practice makes Perfect

Calculate the molarity when 75.0g of MgCl_2 is dissolved in 500.0 mL of solution.

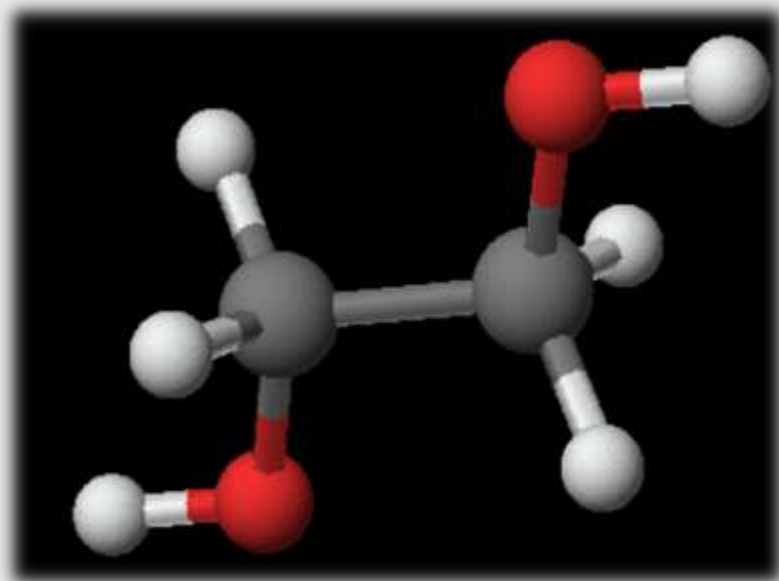
100.0g of sucrose ($\text{C}_{12}\text{H}_{22}\text{O}_{11}$) is dissolved in 1.50 L of solution. What is the molarity?

49.8g of KI is dissolved in enough water to make 1.00 L of solution. What is the molarity?

A chemist dissolves 98.4g of FeSO_4 in enough water to make 2.000 L of solution. What is the molarity of the solution?

Calculating Concentrations

**Dissolve 62.1 g of ethylene glycol in 250.0 g of H₂O.
Calculate molality and % by mass of ethylene glycol (C₂H₄(OH)₂).**



Calculating Concentrations

Dissolve 62 g of ethylene glycol, $\text{C}_2\text{H}_4(\text{OH})_2$, in 250g of H_2O and Calculate the ~~m~~ and % mass (by mass) of $\text{C}_2\text{H}_4(\text{OH})_2$

~~Calculate molality~~

$$\text{Conc. (molality): } \frac{1.00 \text{ mol glycol}}{0.25 \text{ kg H}_2\text{O}} = 4.0 \text{ molal}$$

Calculate weight %

$$\% \text{ glycol} = \frac{62 \text{ g}}{62 \text{ g} + 250 \text{ g}} \times 100\% = 19.9\%$$

Practice makes Perfect

What is the molarity of a solution made by dissolving 0.1356 g MgSO_4 to 200.0 mL in water?

What is the volume of 3.0 M solution of NaCl made with 526g of solute?

Battery acid is generally 3M H_2SO_4 . Roughly how many grams of H_2SO_4 are in 400. mL of this solution?

How many grams of $\text{Sr}(\text{ClO}_4)_2$ are required to make a 0.30 *m* aqueous solution using 600 g of water?